Value-add Solutions for the BGA Supply Chain

Overview

- Premier's "One-Stop-Shop" solution offers many benefits
  - Extensive capacity and multiple locations
  - Provides customers best possible solution in terms of pricing, quality, response & turn-times
  - Sound business model for today's volatile market
  - An effective alternative to expensive in-house processing or cumbersome overseas options

Services

Premier Semiconductor Services provides the most complete offering of outsourced value-add solutions in Final Manufacturing & Test

- IC Counterfeit Detection
- Electrical & Upscreen Test
- Wafer Probe
- Failure Analysis
- IC Programming/Laser Mark
- Lead Straightening
- 3D & Laser Scan
- BGA Reball & Ball Attach
- Sn/Pb & Pb Free Conversion
- Hot Solder Dip and Retinning
- Fine and Gross Leak Testing
- Tape & Reel
- Bake & Dry Pack
- Trim & Form

Locations

- Headquarters – Tempe, AZ
- Facility – South Austin, TX
- Facility – St. Petersburg, FL
- Flextronics: In-Plant – North Austin, TX
- Jabil: In-Plant – Tempe, AZ

Markets & Customers

- Military
- Aerospace
- Automotive
- Medical
- Industrial
- Commercial

- IC Manufacturers
- CM's
- OEM's
- Franchised Distributors
- Independent Distributors

Quality System

- ISO-9001:2000 certification
- ITAR Compliant
- DSCC, QML Approved List
- Employee Training & Certification
- ESD Controlled Environment

Winner of 2007 Impact Award From A Supplier Base of 350

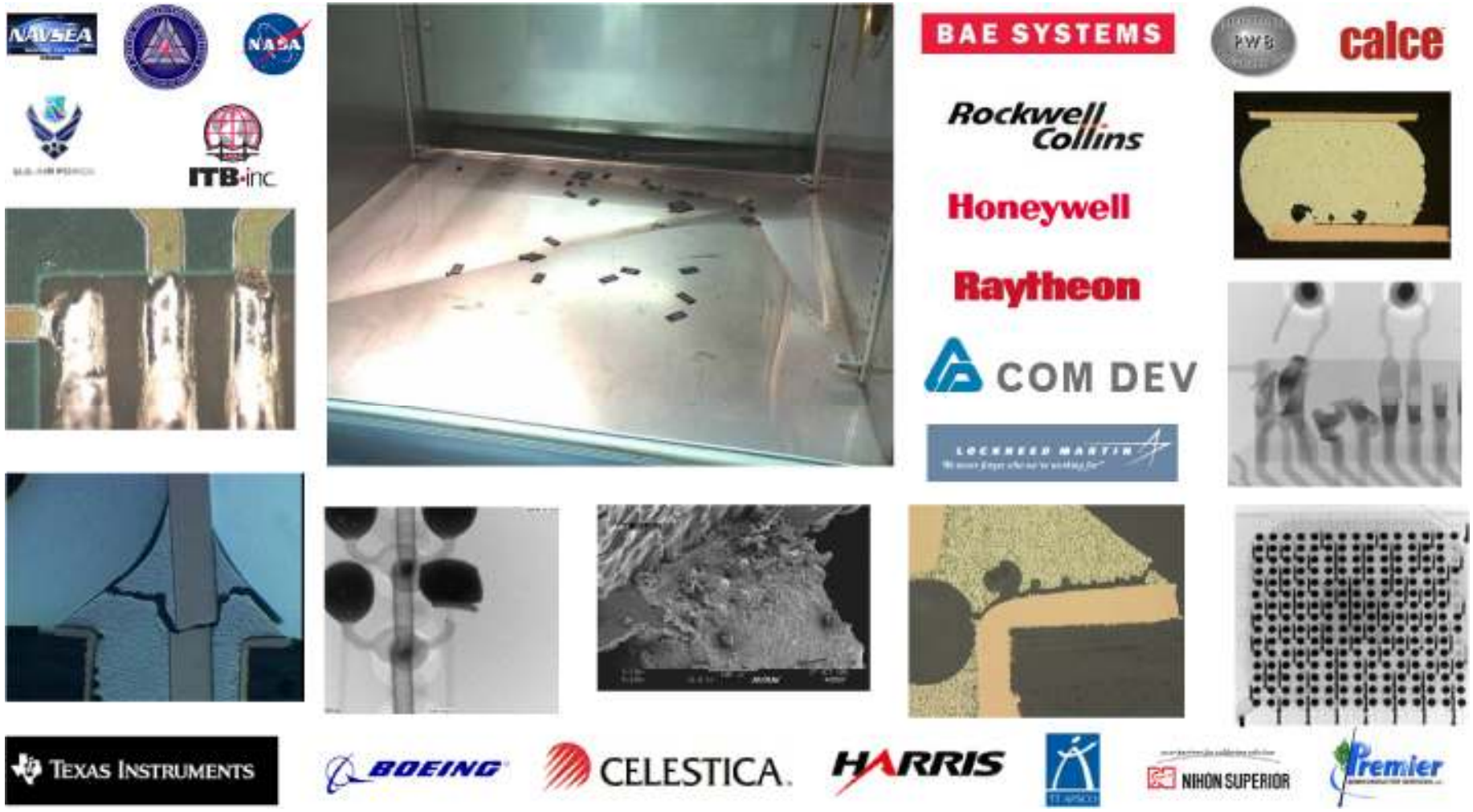
BGA Information

The remainder of this presentation is designed to provide detailed information on the BGA Reball & Ball Attach Processes

OEM Statement

"Lead-free" RoHS initiatives to remove lead from electronic equipment have resulted in challenges for manufacturers. Due to known reliability issues with tin solder alloys (e.g., tin whiskers & voids), companies building high-reliability equipment must approach lead-free soldering with care. A technique being considered for BGA devices is that of re-balling, that is, removal of lead-free solder and replacement by tin-lead spheres. The question is whether this procedure is advisable or if there are other options."

NASA-DoD Project Partners



Military / Aerospace Partners

National Aeronautics and Space Administration (NASA)

Rockwell Collins

NAVSEA
WARFARE CENTERS
CRANE

BAE SYSTEMS

LOCKHEED MARTIN
We never forget who we're working for™

BOEING

Premier
SEMICONDUCTOR SERVICES, LLC

your partner for soldering solution
NIHON SUPERIOR

COM DEV

calce

Raytheon

Interconnect PWB Solutions Inc.

HARRIS

Honeywell

CELESTICA

ITB·inc

TT APSCO

Texas Instruments

U.S. AIR FORCE

Commercial High-Rel Partners

Alcatel-Lucent

Freescale

Premier

Nihon Superior

Sun

Cisco

Juniper

Celestica

Flextronics

IBM

Tekelec

Philips Medical

Agilent

Dell

Fujitsu

HP

ITRI

Motorola

TI

Re-ball Chronology

I. Device removal and refurbishment
For revisions, board rework, PWBA failures, etc

II. Sn/Pb to Pb Free Conversion
For legacy products requiring RoHS Compliance

III. Pb Free to Sn/Pb Conversion
For High reliability products with RoHS exemptions

IV. Sphere attach to Land Grid Array (LGA)
For High reliability products with RoHS exemptions

BGA Reball Process

- Pre-bake
  - 125 degrees for 8 hours
- Strip (not required for LGA's)
  - Vacuum
  - Chemical
  - Auto Strip proprietary process
- Clean
  - DI Water
  - IPA
  - Visual inspection

BGA Reball Process

- Pad Preparation
  - Solder paste
  - Or Flux (Tacky)
    - Water soluble
    - Resin based
  - Visual inspection

- Ball (sphere) Placement
  - Single site platform (Engineering)
  - Multi-site platform (low - medium volume)
  - Large area platform (high volume)
  - Visual inspection

Flux/Paste & Ball Attach

BGA Reball Process

- Re-Flow
  - Single site platform (one per cycle)
  - Batch mode (convection oven)
  - Visual inspection
- Clean
  - DI Water (one per cycle)
  - DI Water (batch)
  - IPA (batch)
  - Visual inspection

Reflow & Clean

Identification & Inspection

- Identification
  - Ink mark
  - Laser mark
  - Printed label
- Post ball attach inspection criteria
  - 2D and 3D inspection
  - Mark Integrity
  - Solder fillet
  - Package warpage
  - Ionic contamination
- Inspection tools
  - Medium power microscope
  - Camera and laser based auto-inspection (ICOS & RVSI)
  - Alpha Metals Model 600R-SC

3D Ball Scan, Tape & Reel

Final Pack & Ship

- Final Pack
  - Moisture bake out
  - Trays or Tape & Reel
  - Dry pack
  - Label
- Shipping
  - Certificate of conformance
  - Inspection reports
  - Packing list
  - Invoice
  - Shipper documents

High Reliability Industry Concerns

- Additional Thermal Exposure
- Intermetallic Interaction
- Device Warranty

Thermal Exposure Control

Profile Feature

- Ramp up rate
- Preheat temperature
- Peak temperature range
- Cool down rate

* Profile feature data is device specific

Ball Attach Integrity Testing

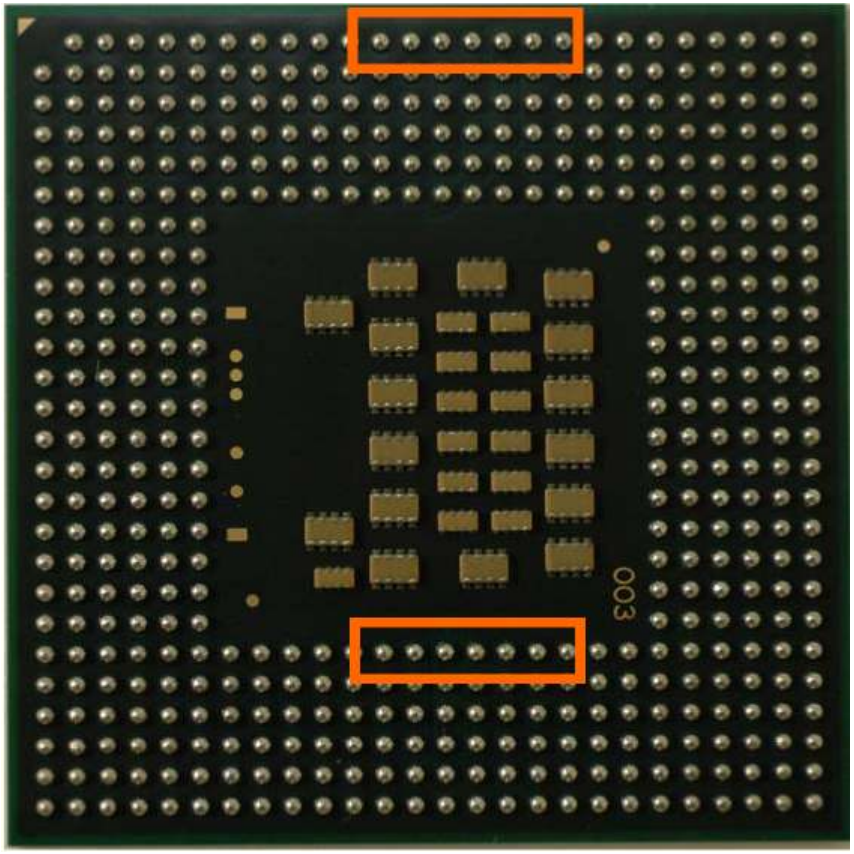
Tests performed to validate the solder ball attachment process

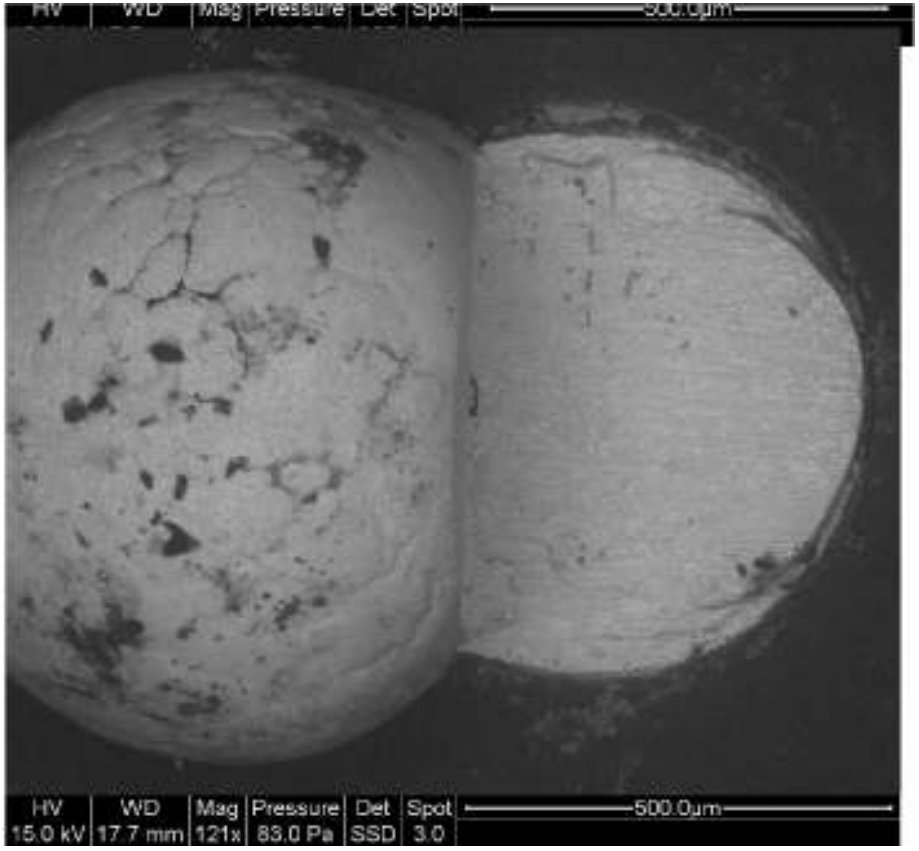
- Shear testing
- C-Sam for Substrate delamination
- SEM Inspection of Solder Joint
- Electrical testing

Shear Strength Data

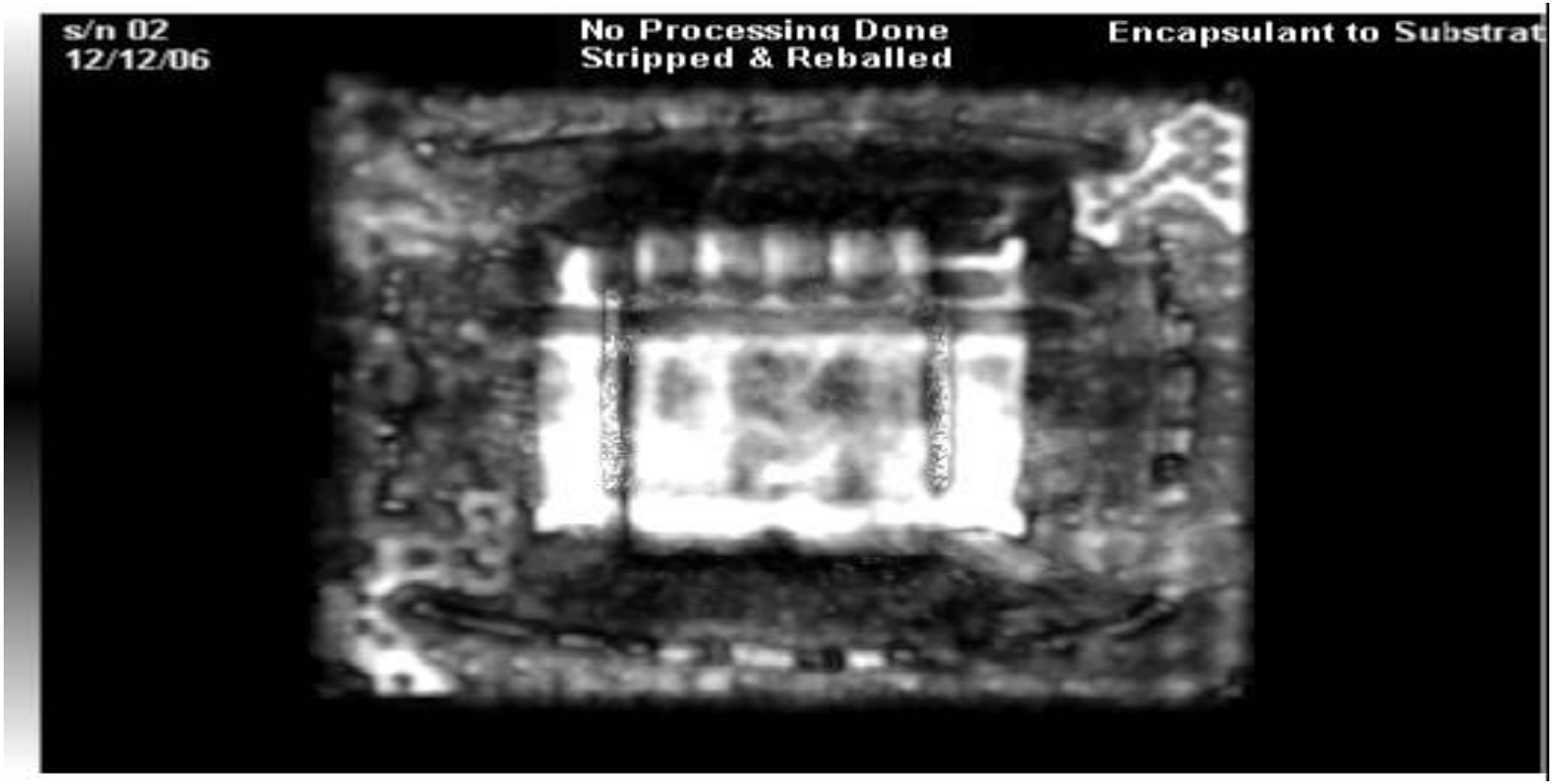
Ball Dia.	Test #	Force (g)	Description	Platform	Load Cell
0.3mm	1	241.58	Pass	Dage 4000	BS5Kg
0.3mm	2	237.18	Pass	Dage 4000	BS5Kg
0.3mm	3	230.50	Pass	Dage 4000	BS5Kg
0.3mm	4	238.53	Pass	Dage 4000	BS5Kg
0.3mm	5	235.77	Pass	Dage 4000	BS5Kg
0.6mm	1	1538	Pass	Dage 2400	BS2Kg
0.6mm	2	1480	Pass	Dage 2400	BS2Kg
0.6mm	3	1701	Pass	Dage 2400	BS2Kg
0.6mm	4	1591	Pass	Dage 2400	BS2Kg
0.6mm	5	1427	Pass	Dage 2400	BS2Kg

0.6mm Ball Shear





C-SAM Photos – No Delimination

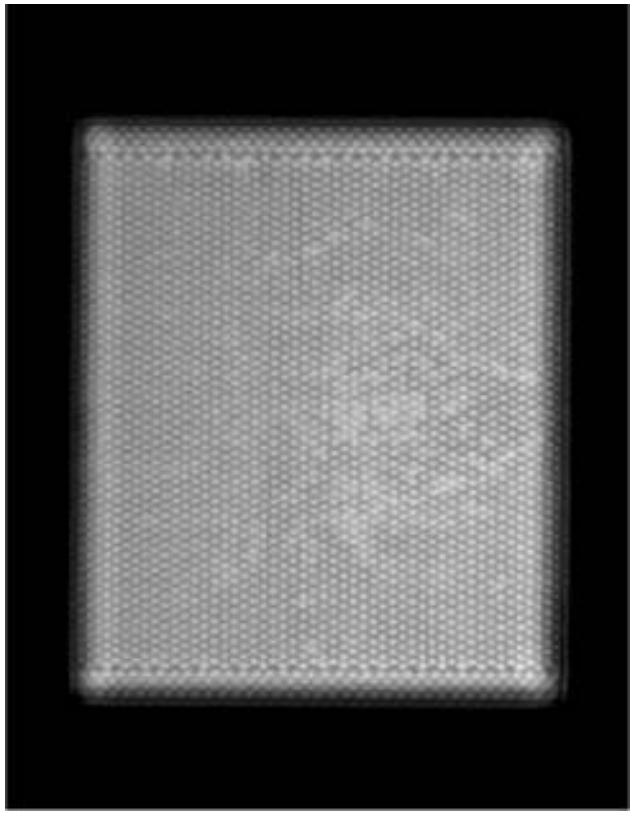


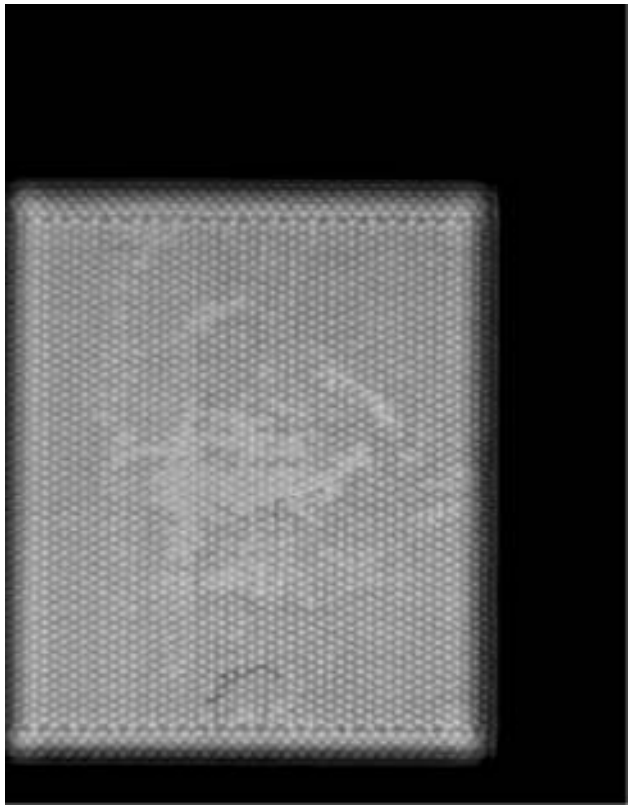
Pb Free to Eutectic

- The following series of photos reflect results of a specific proprietary process.
- The requirement was to convert a series of devices from a SAC405 interconnect structure to a eutectic structure.
- The devices were sent by the customer to an independent laboratory for evaluation.

C-SAM of Flip Chip Bumps

FC die/underfil interface showing no delaminations from Substrate





Acoustic Analysis

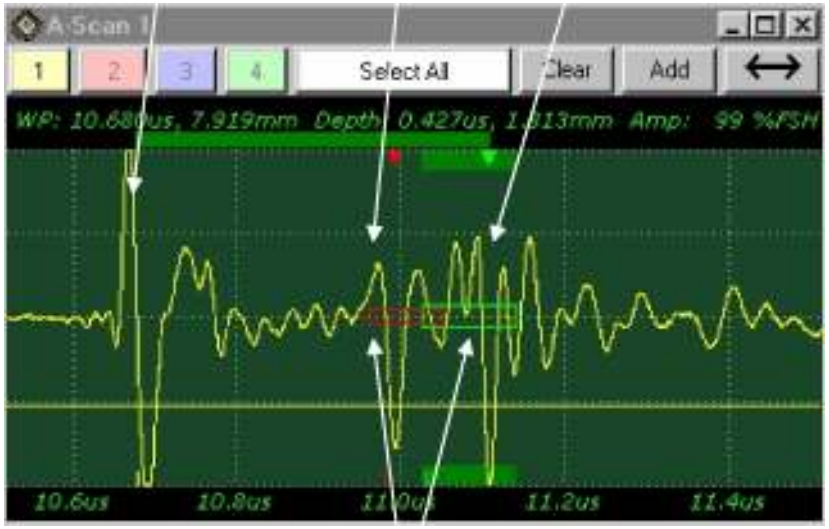
Example of an **Acoustic Transducer Response**
with response gates at special package interfaces of interest.

Twenty four (24) of the forty one (41) packages were subjected to CSAM analysis. The purpose of this evaluation is to make sure that multiple re-flow temperature profiles subjected to the packages during the lead free ball removal and the subsequent re-balling process did not initiate or cause underfil delaminations at the flip chip die interface.

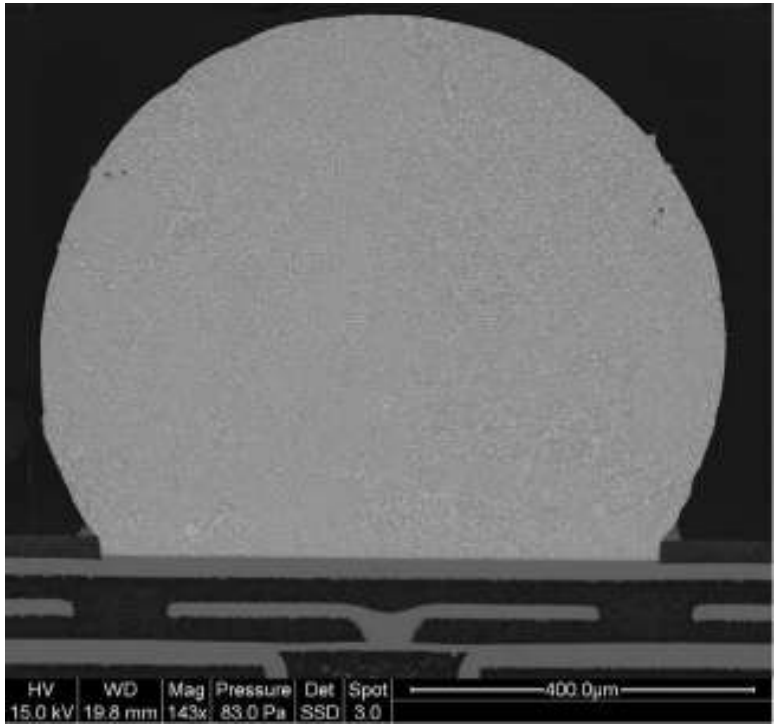
This type of evaluation is normally recommended to be performed when Flip Chip (FC) packages are exposed to temperature excursion or profiles. Underfil delaminations can either failures or compromise the integrity and reliability of the package solder bump interconnects.

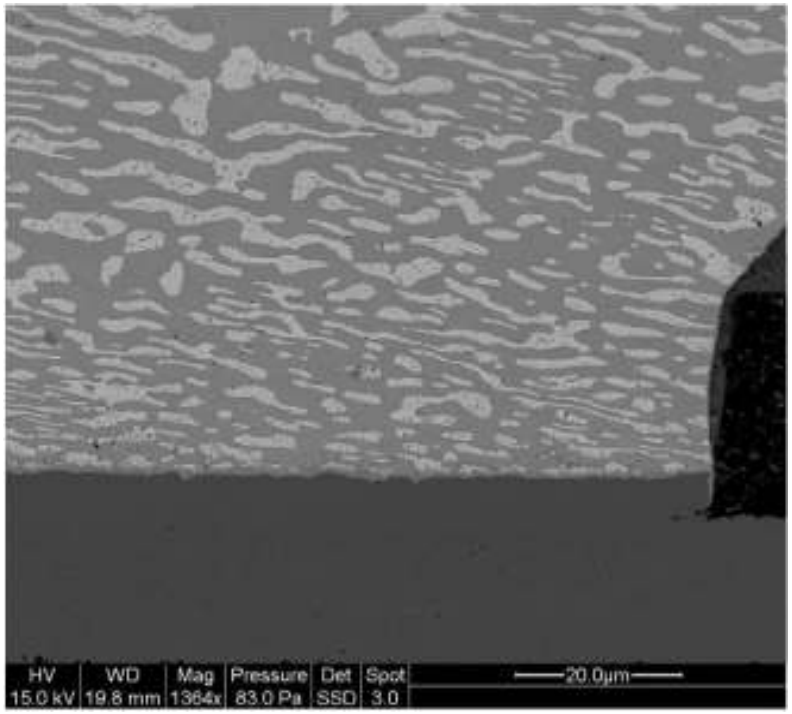
Acoustic Analysis Chart

Illustration of Acoustic Transducer Response Chart

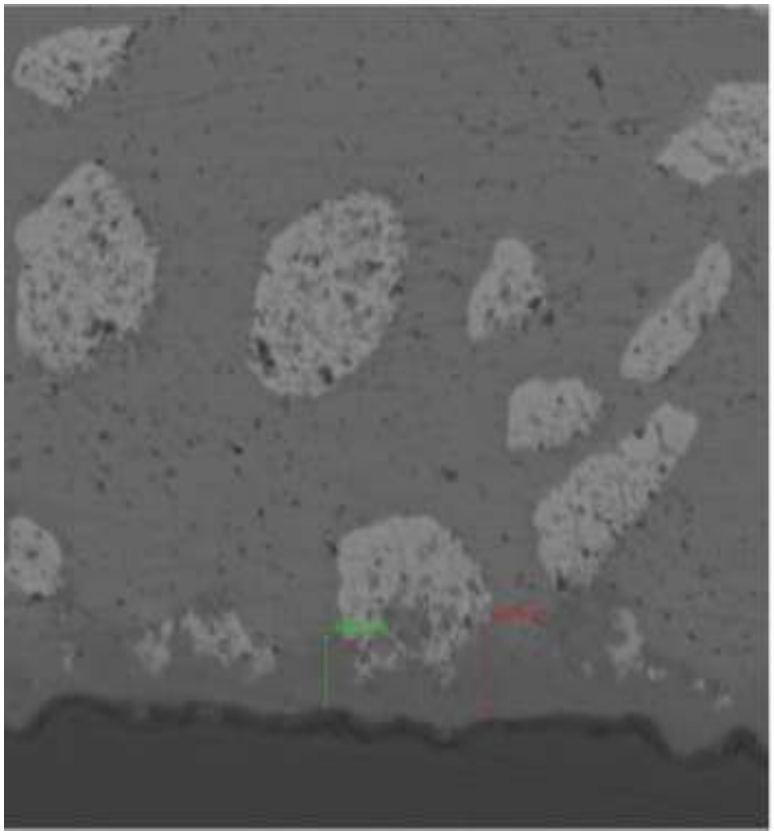


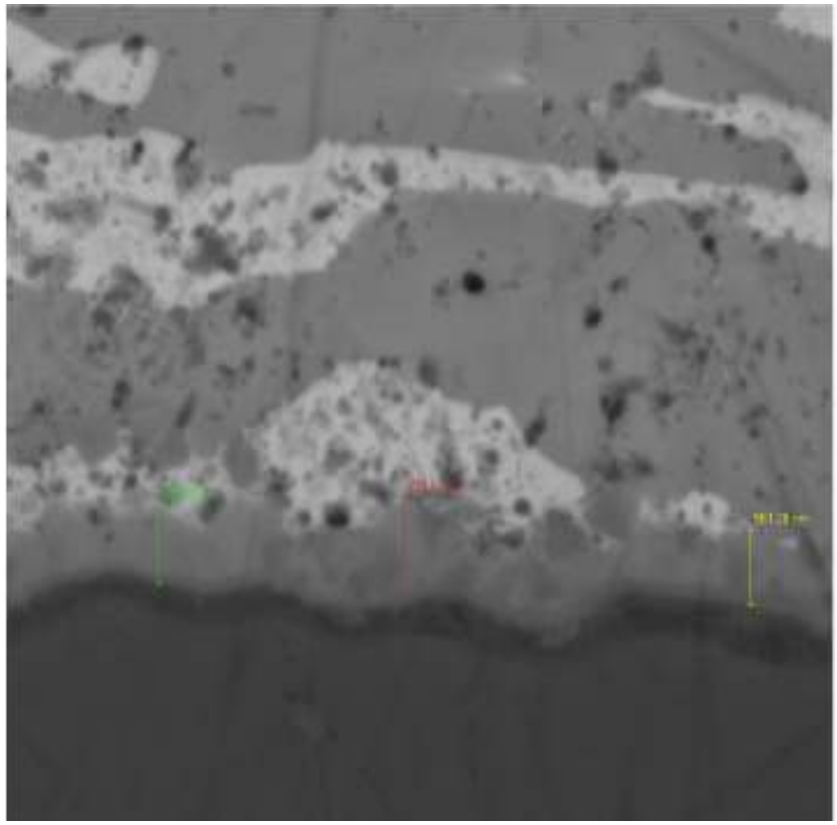
Solder Joint





Intermetallic Region





Analytical Conclusions

- X-ray inspection showed no voiding.
- Cross sections showed good metallurgical ball attachment.
- CSAM analysis - no FC/underfil interface delamination
- Extensive solder ball shear performed showed good BGA to substrate solder joints with tight shear force range all above the industry acceptable level. The shear failure was always in the bulk solder indicating strong solder joint to the substrate pads.

Premier Electrical Test Capabilities

Proposed High Reliability Device Plan

- Outsource Hi-Rel devices to PS2 after Deflash process step for completion.

-- OR --

- Produce off roadmap device in a Land Grid Array (LGA) format for marketplace.

Proposed High Reliability Device Plan

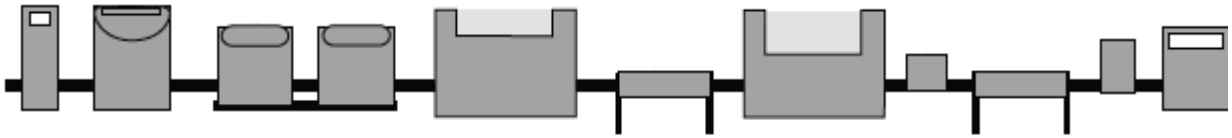
- Mark parts indicating off roadmap processing
- Limited Functional Test
- Inspect & re-package parts
- Store parts in bonded stock
  - Shipment to OEM on as needed basis

Proposed Process Flow

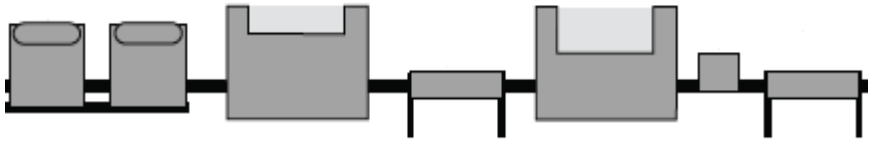
Wafer Dice – Sort – Die Attach / Flip Chip Attach – Underfil – Wire Bond – Encapsulate – Deflash

Premier's Processes:

Inspect – Clean – Flux/Paste Print – Sphere Attach – Inspect – Re-flow – Inspect – Clean – Mark – Inspect – Scan



Singulate - Functional Test – Scan – Final Pack – Inspect - Ship



Partner With Premier

- The BGA Re-balling process has no "one size fits all" product solution, with industries demanding reliable, verifiable, and cost effective options for lead free to eutectic solder ball conversions.
- Premier offers customers real alternatives in the reballing process, by providing a turn-key BGA solution, as part of the most complete offering of outsourced backend services available in the US today.
- Combining technical expertise, state of the art equipment, capacity and an ISO9001-2000 quality system, Premier has a proven solution.
- Partner with Premier as your BGA Reballing services provider !

BGA Inquiry Contact Information

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